

DescriptionDevice for separating impurities from the lubricating oil
of an internal combustion engine

The present invention relates to a device for separating impurities from the lubricating oil of an internal combustion engine, said device comprising a filter element, wherein said filter element is arranged in a two-piece housing that is closed during operation of the device and comprises a stationary lower housing part and a removable upper screw cap and wherein said screw cap and said filter element comprise detachable connection means which can be brought into contact and are used to transmit axial tractive forces, wherein the filter element is removed from the housing by means of these connection means when the screw cap is rotated in its loosening rotational direction.

Furthermore, the present invention relates to a device for separating impurities from the lubricating oil of an internal combustion engine, said device comprising a filter element at its bottom and, on top of said filter element, a centrifuge with a rotor drivable by means of lubricating oil flowing through it, wherein said filter element and said centrifuge are arranged, one above the other, in a common two-piece housing that is closed during operation of the device and comprises a removable upper screw cap and a stationary lower housing part,

wherein a removable intermediate cap is arranged in the housing between said filter element and said centrifuge, said intermediate cap and said filter element comprising first detachable connection means which can be brought into contact and are used to transmit axial tractive forces, and wherein said centrifuge, said intermediate cap and said filter element can be removed from the housing while the latter is in its open state.

A device of the first aforementioned type is, for example, known from DE 296 10 290 U1, which describes a device that is designed as fluid filter and which provides that the upper end disk of the filter element is provided with locking tongues that are projecting towards the top and can be mounted elastically. With the device being in the assembled state, these locking tongues engage a continuous locking groove extending along the internal perimeter of the screw cap. This permits removal of the screw cap, along with the filter element, from the filter housing by rotating said screw cap in its loosening rotational direction, this allowing the filter element to be handled easily when being replaced, wherein it is not necessary to directly seize the dirty and oily filter element. Usually, a used-up filter element is separated from the screw cap by canting the two parts against each other until the locking connection is undone. This requires canting beyond a certain angle to ensure that the locking connection will indeed be undone. In case of screw caps which provide only little lateral motional play for the filter element partially arranged therein, this especially being the case with relatively long screw caps, it is not possible to undo the locking connection by canting because the deflection angle required between the two parts fails to be achieved since the filter element touches the internal perimeter of the screw cap be-

forehand. In this case, great effort is required to undo the locking connection by exerting a tractive force in axial direction. To achieve this, the dirty filter element must be seized, and in this process, contaminated lubricating oil may easily be released into the environment. In addition, it is difficult to exert the necessary tractive force at all when seizing an oily filter element.

A device of the second aforementioned type is known from DE 43 06 431 C1. If the screw cap, as a removable part of the housing of this known device, is rotated in its loosening rotational direction, initially only the screw cap, in its thread, moves away from the stationary part of the housing in an upward direction, whereas the centrifuge rotor that is arranged in the upper part of the housing remains in its position. After the housing cap has been removed, the rotor of the centrifuge is positioned in its lower bearing. In the next step, the centrifuge rotor can be removed. Thereafter, the intermediate cap is accessible. The intermediate cap must be pulled out of the lower part of the housing in an upward direction. Therein, the intermediate cap takes along the filter element that is arranged below it, thus also removing it in an upward direction. This taking along is initiated by the first detachable connection means between the intermediate cap and the upper end disk of the filter element. After the combined unit consisting of intermediate cap and filter element has been removed, the filter element can, by canting or by exerting a tractive force in axial direction, be disengaged from and pulled out of the intermediate cap, and a new filter element can be inserted in the intermediate cap and engaged therewith via the detachable connection means by exerting a thrust force in axial direction. As compared with its disassembly, the device is

then assembled in reverse order by first introducing the intermediate cap including filter element in the lower part of the housing. Thereafter, the centrifuge rotor is placed onto the intermediate cap with its lower bearing. Finally, the screw cap is screwed on, while it must be ensured that the upper bearing of the centrifuge rotor assumes its desired position in the center of the upper end of the screw cap. Obviously, disassembly and assembly of this device are relatively complicated and troublesome. In addition, disassembly requires that oily parts, in particular the intermediate cap, be seized manually. Apart from operating personnel getting their hands dirty, this poses the further problem that it is difficult to get a sufficiently firm hold of the intermediate cap because of its oily surface. As a result, it is even more difficult to pull out the intermediate cap from the lower part of the housing against the developing frictional forces and against a vacuum that might possibly be present.

Therefore, the present invention aims at creating devices of the aforementioned type, which obviate the drawbacks described above and which allow, in particular, disassembly and assembly to be carried out in an easier, faster and cleaner manner.

A first solution to this problem is provided by the invention by a device of the first aforementioned type, characterized in that the connection means can be brought into contact by rotating the screw cap in the loosening rotational direction thereof and can be disengaged by rotating the screw cap in the tightening rotational direction thereof.

The device according to the invention is to advantage in that the connection means can, if necessary, be brought into contact and be disengaged by a simple rotary motion. Therein, engaging and disengaging practically do not require any effort as is the case with a locking connection when the locking connection is to be established or undone. At the same time, however, the device according to the invention ensures that, when the screw cap is rotated in its loosening rotational direction, the filter element also makes the movement of the screw cap away from the remaining filter housing in the manner desired. As a result, this device also facilitates clean removal of the filter element from the filter housing because the filter element is, at the same time, taken along and out of the filter housing when the cap is removed, thus not having to be taken out of the filter housing separately by operating personnel. Again, a small rotary motion, now in the tightening rotational direction of the screw cap, suffices to separate the filter element from the screw cap, whereby the connection means between the filter element and the screw cap are disengaged and the filter element is separated from the screw cap. Thereafter, the used-up filter element can be disposed of and can be replaced by a new filter element. Said new filter element can then be connected to the screw cap via the connection means in a likewise easy manner by a simple rotary motion and can then be inserted in the filter housing jointly with the screw cap and fixed in its position in the filter housing by rotating the screw cap in its tightening rotational direction. Proper functioning of this type of connection means is ensured irrespective of the amount of a possible lateral motional play of the filter element inside the screw cap because, for being engaged and disengaged, the connection means do not require any lateral motion but must only be rotated in relation to each other. This en-

ables this type of connection means to be used to particular advantage in long screw caps which, when a formerly usual locking connection was used, caused problems in undoing said locking connection.

A first preferred further development of the device provides that the angle of rotation covered by the screw cap between the disengaged position and the engaged position of the connection means ranges from approximately 15 degrees to 30 degrees. With such a small angle of rotation, a very small and very quickly and easily executable manual rotary motion of the parts of the device that comprise the connection means in relation to each other suffices for engagement and disengagement.

To also permit use of current filter elements that have already been launched and are already existing on the market in the device according to the invention, a further embodiment of the device proposes that the filter-element-side connection means are formed by a concentric circle of snap-on hooks that is anyway present at an upper end disk of the filter element and that the associated connection means of the screw cap are formed by a ring with cam segments that is concentrically arranged at the bottom side of the upper part of said screw cap, wherein, in a first rotational position that can be adjusted by rotating in tightening rotational direction, the circle of snap-on hooks can be moved in axial direction into the ring and out of the ring with the cam segments in relation to each other and wherein, in a second rotational position that can be adjusted by rotating in loosening rotational direction, the circle of snap-on hooks that has been moved into the ring cannot be moved out of the ring with the cam segments in axial direction in relation to each other. In this embodiment of the de-

vice, it is only necessary to modify the inner side of the screw cap; thereafter, the connection between the screw cap on the one hand and the filter element on the other hand can be established and undone in a manner according to the invention. As compared with the formerly usual filter elements, it is not necessary to make any modifications to the filter element, so that conversion to the new type of connection can be achieved with very little technical effort.

To enable the screw cap of the housing to be provided with its connection means in as easy a manner as possible, a further embodiment of the device provides that the ring with the cam segments is inserted in a recess of the screw cap as a separate component such that it can neither be rotated nor lost. This initially permits manufacture of the cap with the region of its recess being formed relatively easily. Subsequently, the ring is installed in this recess, wherein the two parts can be connected to each other by being mutually welded or glued or engaged such that they can neither be rotated nor lost.

A second solution to this problem is provided by the invention by a device of the second aforementioned type, characterized in that

- the screw cap and the intermediate cap additionally comprise second detachable connection means that can be brought in contact and are used to transmit axial tractive forces,
- the second connection means can be brought into contact by rotating the screw cap in its loosening rotational direction in relation to the intermediate cap and can be disengaged by rotating the screw cap in its tightening rotational direction in relation to the intermediate cap, and

- the first connection means can, in relation to the filter element, be brought into contact by rotating the screw cap in its loosening rotational direction, said screw cap taking along the intermediate cap, and can, in relation to the filter element, be disengaged by rotating the intermediate cap in opposite direction.

The contact required for transmission of tractive forces acting in axial direction is, to advantage, established only if it is indeed required, that is during disassembly of the device. This contact is simply generated by rotating the screw cap in its loosening rotational direction, a step that is anyhow required for unscrewing the screw cap from the stationary part of the housing. Both the first and the second connection means are brought into contact by the rotary motion of the screw cap in its loosening rotational direction. Hence, on completion of the procedure of unscrewing the screw cap from the stationary part of the housing, there is contact between the screw cap and the intermediate cap as well as between the intermediate cap and the filter element. This permits the operating personnel to seize only the screw cap that is usually clean on its outside; pulling out does not require that the oily further parts of the device that are removed from the housing be seized. On the contrary, the screw cap, when moving upwards, takes along the centrifuge rotor, the intermediate cap and the filter element in the same upward movement direction. The unit comprising screw cap, centrifuge rotor, intermediate cap and filter element that is removed from the housing can then be separated easily by being rotated in opposite rotational direction in relation to each other, because this rotation that is now effected in opposite direction disengages the connection means between the screw cap and the intermediate cap as well as between the intermediate

cap and the filter element. After completion of this disengagement, all parts of the device that have been removed from the stationary housing part, that is the filter element, the intermediate cap, the centrifuge rotor and the screw cap, can be separated from each other. After the filter element and the centrifuge rotor have been replaced by new components, assembly is carried out in reverse order and with opposite rotational directions. Thereafter, a new unit comprising screw cap, centrifuge rotor, intermediate cap and filter element has been pre-assembled, which, as a unit, can be inserted in the lower part of the housing and can be connected to the remaining housing by rotating the screw cap. Rotation of the screw cap in its tightening rotational direction causes the previously established connection contacts to be disengaged, because said connection contacts are neither required when the screw cap is rotated in its tightening rotational direction nor when the screw cap is in its tightened state.

In a further embodiment of the second device according to the invention, it is preferably provided that the angle of rotation covered by the screw cap between the disengaged position and the engaged position of the first and second connection means in relation to the filter element is, altogether, ranging from approximately 45 degrees to 120 degrees. Owing to this angle of rotation that is relatively small despite two connection contacts that must be established and undone, said contacts are swiftly established when the screw cap is rotated in its loosening rotational direction, requiring only a short distance to be covered, and are likewise swiftly undone when the screw cap is rotated in its tightening rotational direction, again requiring only a short distance to be covered.

In a more concrete further development of the second device, it is provided that the intermediate cap has the shape of a bell and comprises at its outer perimeter axially extending fins each of which is provided with at least one broadening or aperture pointing in circumferential direction and that the screw cap comprises at its lower edge hooks or noses that are pointing in its loosening rotational direction and can be brought into contact with the broadenings or apertures by rotating the screw cap in its loosening rotational direction in relation to the intermediate cap and can be disengaged by rotating the screw cap in its tightening rotational direction in relation to the intermediate cap. In this embodiment, it is only necessary to form several, for example three, hooks or noses that fit to the screw cap and are distributed over the perimeter thereof and at the lower end edge thereof, this requiring only little additional effort during manufacture of the screw cap. The effort additionally required in the manufacture of the intermediate cap for the formation of the broadenings or apertures as connection means cooperating with the hooks or noses is likewise relatively low, so that the manufacture of the intermediate cap does not require any noticeable additional effort, that would increase the price of the device, either.

A further development of the device provides that the fins that comprise the broadenings or apertures are, at the same time, used as stabilization and force diverting fins for reinforcing the intermediate cap and for diverting onto the screw cap such forces that are caused by an oil pressure below the intermediate cap in the interior region of the housing. As a result, the fins assume two functions, thus minimizing the material and manufacturing

expenditures required for achieving as many functions as possible.

To ensure that, with the screw cap unscrewed from the stationary housing part, the intermediate cap that is connected to said screw cap via the connection means that are now in contact and the filter element connected thereto are prevented from falling off and, thus, being damaged in an unintentional manner, it is furthermore preferably provided that the broadenings or apertures on the one hand and/or the hooks or noses on the other hand are each provided with a slope or step at their surfaces that are brought into contact, said slope or step securing the engaged position. As a result, a certain, yet relatively low motional resistance must be overcome for disengaging the connection by rotating the parts in relation to each other, said motional resistance being, however, at any rate great enough to prevent the parts from detaching from each other by themselves in an unintentional manner.

Instead of in the region of the fins at the outer perimeter of the intermediate cap, the second connection means can also be arranged at a different point. To achieve this, a preferred further embodiment provides that the intermediate cap has the shape of a bell and comprises, in a radially outer region of its upper side, several wings that are pointing in an axially upward direction, are spaced apart from each other in circumferential direction and are each provided with at least one broadening or aperture pointing in circumferential direction or with a depression used as connection means and recessing in a radially inward direction and that the screw cap comprises at its lower edge hooks or noses as connection means that are pointing in the loosening rotational di-

rection of the screw cap or in a radially inward direction, wherein said connection means can be brought into contact with the connection means of the intermediate cap by rotating the screw cap in its loosening rotational direction in relation to the intermediate cap and can be disengaged by rotating the screw cap in its tightening rotational direction in relation to the intermediate cap. This embodiment is to particular advantage in case of devices with a shorter screw cap that does not extend to the region below the upper part of the screw cap.

In order to prevent the second connections means from positioning in front of each other and jamming in axial direction when the screw cap is rotated in its tightening rotational direction, it is provided that the second connection means are arranged and designed such that they overlap each other in axial direction when the screw cap is placed onto the remaining housing before the thread engagement thereof.

To allow easy and quick mounting of the device, it is appropriate that the parts of the device can be joined to form pre-assembled units. To achieve this, it is provided that the wings comprise, at their radially outer end, a guide contour fitting in the interior region of the screw cap with motion play. This guide contour ensures that the intermediate cap, including the centrifuge rotor it is carrying, can be aligned in an exactly axial direction when being inserted in the screw cap, wherein it is ensured that an upper shaft end of a rotor shaft is positioned precisely in a shaft holding in the center of the upper inner side of the screw cap. The filter element can already be attached to the other side of the intermediate cap so that the pre-assembled unit then, to advantage,

comprises all of the parts to be installed in the housing and to be connected to the housing.

During operation of the device, a considerable lubricating oil pressure is present below the intermediate cap, whereas the region above the intermediate cap is pressureless. In order to absorb the forces caused by the pressure difference and acting on the intermediate cap and to divert said forces into the screw cap, it is provided to provide a step at or next to each of the wings, said step projecting in a radially outward direction and forming the basis on which the lower edge of the screw cap is supported when the latter is in the tightened state.

To increase the overall stability and load carrying capacity of the wings and the intermediate cap, it is proposed that the wings be connected to each other via a continuous circumferential collar or be joined to form a continuous circumferential collar.

A further measure to prevent additional manufacturing expenditures and to allow the use of current filter elements even in the second device according to the invention comprises filter-element-side connection means that are formed by a concentric circle of snap-on hooks that is anyhow present at an upper end disk of the filter element and further comprises associated connection means of the intermediate cap that are formed by a ring with cam segments that is concentrically arranged at the bottom side of the upper part of said intermediate cap, wherein, in a first rotational position that can be adjusted by rotating in tightening rotational direction, the circle of snap-on hooks can be moved in axial direction into the ring and out of the ring with the cam segments in rela-